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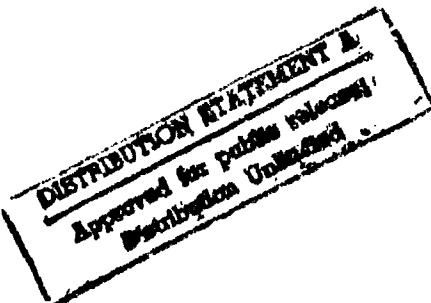
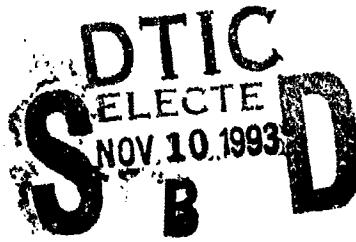
LONG DURATION EXPOSURE FACILITY (LDEF) CONTAMINATION STUDY

FINAL REPORT

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SUMMARY

This Report describes the optical measurements that were taken of LDEF surfaces during the deintegration of LDEF from February to April 1990. This project was one part of an overall effort conducted by Boeing Aerospace to determine and track contamination on LDEF.

The purpose of this portion of the contamination project was to provide early documentation of the contamination level on LDEF experiments before shipment and disassembly by the principle investigators (PI). 35% of experiment trays located on all areas of LDEF were examined to, in particular, catalogue global differences in contamination depending on tray location.

The optical measurements were performed with a Model BHMJ Nomarski microscope which had also darkfield and oblique lighting capabilities. The optical measurements were documented by video and 35-mm cameras that could be attached to the microscope. Approximately 15 hours of video and 17 rolls of film (24 exposure) were taken. A full list of all trays and experiments observed is presented in Appendix C. Due to the high volume of data, a short 10-min. video has been compiled to illustrate the different contamination processes observed on LDEF.

LONG DURATION EXPOSURE FACILITY

The Long Duration Exposure Facility (LDEF) was a free-flying cylindrical structure that accommodated 86 experiment trays containing 57 experiments. The LDEF was launched in April 1984 at an orbit of 257-nmi and at an inclination of 28.5 degrees by the Space Shuttle Challenger on mission STS 41-C. The LDEF was retrieved in January 1990 at an altitude of 179-nmi on mission STS-32 by the Space Shuttle Columbia. Originally the LDEF mission was only scheduled for one year, but due to launch delays and the Challenger accident, the mission was extended to five years and nine months. This delay did have some catastrophic effects on some of the experiments.

The 30 foot by 14 foot diameter structure contained experiments belonging to four main experiment categories: 1) materials, coatings, and thermal systems; 2) power and propulsion; 3) science; 4) optics and electronics. A description of all experiments can be found in reference 1.

Since the LDEF was in a passively stabilized orbit, the experiments were exposed to very consistent conditions that depended on tray location. Trays were located around the LDEF in 12 rows with six trays in each row. Trays were also located on both ends of LDEF. The LDEF structural configuration and experiment location are illustrated in figure 1 (ref 1, pg. 3).

| Bay Row | A | B | C | D | E | F |
|---------|-------|---|----------------------------------|-------------------------|---|-------------------------|
| 1 | A0175 | S0001 | Grapple | | | |
| 2 | A0178 | S0001 | A0015 A0187 M0006 | A0189 A0172 | S0001 | A0178 P0004 P0006 |
| 3 | A0187 | A0138 | A0023 A0034 A0114 A0201 | M0003 M0002 | A0187 S1002 | S0001 |
| 4 | A0178 | A0054 | S0001 | M0003 | S0001 | A0178 |
| 5 | S0001 | A0178 | A0178 | A0178 | S0050 A0044 A0135 | S0001 |
| 6 | S0001 | S0001 | A0178 | A0201 P0003 P0005 | S0001 A0023 S1006 S1003 M0002 | A0038 |
| 7 | A0175 | A0178 | S0001 | A0178 | S0001 | S0001 |
| 8 | A0171 | S0001 A0056 A0147 | A0178 | M0003 | A0187 | M0004 |
| 9 | S0069 | S0010 A0134 A0203 A0114 A0201 | A0034 A0201 | M0003 M0002 | S0014 | A0076 |
| 10 | A0178 | S1005 | Grapple | A0054 | A0178 | S0001 |
| 11 | A0187 | S0001 | A0178 | A0178 | S0001 | S0001 |
| 12 | S0001 | AC201 | S0109 | A0023 A0019 A0180 | A0038 | S1001 |

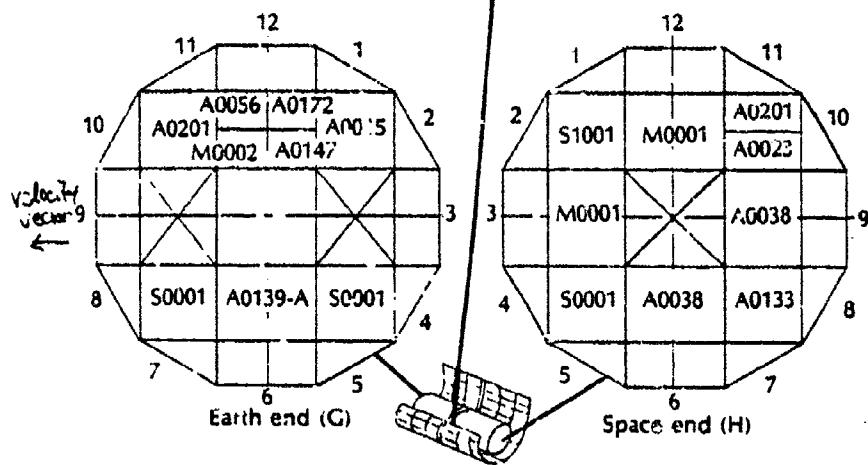


Figure 1: LDEF Experiment Model

Throughout this report, experiment location will be given by bay (A-F) and row number (1-12). For example, position A-9 signifies experiment S0069 as seen in fig. 1. Positions to particularly note are rows 3 and 9, which correspond to the trailing edge (very little exposure to atomic oxygen) and the leading edge (very high

Avail and/or
Dist Special
A-1

exposure to atomic oxygen), and positions starting with G (earth end) and H (space end). The correlation of experiment number, title, and tray locations are listed in Appendix A (ref 2, pp. 15-19).

LDEF DEINTEGRATION

After Columbia landed at Edwards Air Force Base it was ferried across the U.S. by a Boeing 747 to Kennedy Space Center (KSC). Upon arrival the LDEF was removed from the Shuttle and eventually moved to a clean room in the SAEF II building. The deintegration of the experiment trays started on February 23 and was completed on March 27, 1990. The procedure to deintegrate a tray was to remove it from the LDEF structure and circulate it through three locations. The first stop was in a special area to conduct a detailed photographic survey. Next the tray was moved to the Meteoroid and Debris Special Investigation Group (M/D SIG) which conducted a systematic scan of outer structures for impacts. Finally the tray was moved to the Systems SIG (with principal investigator (PI) approval) for a noncontact contamination evaluation using a Nomarski microscope. Since optical elements are often the most affected by contamination and were also the most effectively observed with a Nomarski microscope, experiments containing optical elements were pursued. After deintegration of each tray, the PIs received them and arranged for shipment to their laboratories.

LDEF CONTAMINATION PROGRAM

Four Special Investigation Groups (Meteoroid and Debris, Systems, Materials, and Radiation) were created, before the LDEF recovery, to investigate effects of low earth orbit (LEO) on material samples and systems that were not specifically being studied by the PIs. For example, the Systems SIG was chartered to analyze the performance of LDEF systems and experiment systems (including optical systems). The subject of contamination was more difficult to place in a specific SIG so the duties were shared between the Materials and Systems SIGs. A contamination committee was formed to raise awareness of contamination problems and insert procedures to reduce these problems in the deintegration effort and to measure contamination that had already occurred. Boeing Aerospace was commissioned to monitor contamination levels in the deintegration building (SAEF II) as well as trace the entire contamination history from prelaunch, retrieval, to deintegration. The observation of experiments with the Nomarski microscope was one part of an overall effort to determine and track contamination on LDEF.

THE NOMARSKI MICROSCOPE OBSERVATIONS

The purpose of the Nomarski portion of the contamination project was to provide early documentation of the contamination level on LDEF experiments before shipment and disassembly by the principle

investigators (PI). 35% of experiment trays located on all areas of LDEF were examined to, in particular, catalogue global differences in contamination depending on tray location. It was also thought that the video could serve as an early permanent detailed record of experiment conditions upon arrival at KSC, before shipment and possible exposure to damage. The video is one of the few records that contains observations made of many different experiments (at high magnification) located on all areas of LDEF.

The optical measurements were performed with an Olympus Model BHMJ Nomarski microscope which had also darkfield and oblique lighting capabilities. This instrument was chosen because it was light-weight and portable, and could make observations of objects in a vertical orientation. A source transmitted by a 7-mm flexible light-guide was used to increase flexibility in illuminating a given experiment. It was possible to point the light-guide directly at an experiment surface to do oblique lighting studies. The microscope had a 10x binocular eyepiece and five different objectives to allow a magnification range of 50x to 800x. The optical measurements were documented by video and a 35-mm camera that were borrowed from Boeing Aerospace. A portable boom stand was also purchased to hold the microscope and allow a variety of vertical positions. An additional rail system was designed and built by NASA personnel to allow the whole microscope to be moved along an experiment tray during observation (see appendix B).

The procedure for a typical tray observation went as follows. Our group was usually asked if we would want to do observations on a given tray that was passing through the deintegration process. If any part of the tray contained optics samples, or had a surface conducive to observations with a Nomarski, we would ask the PI for permission to analyze the tray. Next the tray would be rolled over with a tray stand and placed next to the microscope in a vertical position. Normally we were given only 0.5 to 2 hours to observe a tray, so the work had to move very quickly. Notes were written rapidly correlating observations with the video tape counter number. A television monitor assisted in the note taking. An experiment would be scanned until something of interest was found, then the magnification was increased for a more detailed analysis. All magnification changes and observations were written in the experiment notes. For particularly interesting features, the 35-mm camera was substituted for the video head and slides were taken. It was often necessary to make maps of experiment samples because neither our group nor the PI knew what sample material we were observing. Sometimes there would be up to 30 samples, so we did our best to number them and observe them all in the short time we had with each experiment. In all, approximately 15 hours of video and 17 rolls of film (24 exposure) were taken. A full list of all trays and experiments observed is listed in Appendix C.

NOMARSKI OBSERVATION RESULTS

This part of the contamination study was noncontact as stated. The data obtained was only a first step in a lengthy process to determine the types and sources of contamination present on LDEF. At no time was the purpose of the study to analyze individual PI experiments. Much of the data collected was used to guide other parts of the study (tape lifts, witness plates, microchemical tests, electron microscopy, and other contact analysis tests of actual experiments) that were able to collect more quantitative data. As one example, the Nomarski observations revealed that there was a high population of glass fibers on all experiments, but the source was unknown. Later, through the other analyses discussed above, several sources of glass fibers were found including: 1) shuttle bay liner; 2) shuttle tile fiber; 3) glass fiber from glass fiber/resin composites; 4) HEPA filter fiber (ref. 3, pp. 104-105).

There were many early observations, like the example given above, made using the Nomarski microscope. Following is a numbered list of some of these other observations that will be referred to later when discussing the overview video that has been created for this report.

- 1) One of the early observations made was the presence of shadows behind particles and fibers on experiment surfaces. The shadows were a result of local shielding of the surface material from some external event. For example, on the silver/Teflon (Ag/FEP) thermal control blankets (A0178) on the leading edge, the particulates shielded the Teflon blankets from atomic oxygen erosion of the surface. On the trailing edge the particulates shielded the Ag/FEP surface from the deposition of molecular contamination due to nearby outgassing events (shielding from ultra-violet exposure also created this same type of shadowing). However, on the same Teflon surfaces, there was debris present that had no nearby shadowing which indicated that the debris had arrived during recovery or deintegration. This phenomenon became a very important discovery because it revealed when contaminants had entered the system. Furthermore, there were shadows with no particles present, and debris that were displaced from their shadows. This type of information indicated how much particulates had been displaced during recovery and deintegration.
- 2) In scanning over many experiment surfaces, it became clear that there was a lot of organic fibers. The main sources were from clothing (cotton, polyester, wool etc.), wood fiber from nonclean-room paper, rug fiber, etc. Most of the sources were determined by other tests, though the polyester fiber was easily identified because of its high birefringence which was observed by rotating the polarizer on the microscope. From the shadowing, it was clear that all these types of contaminants were present before launch, but also had entered during deintegration. Other sources of "people" contaminants included skin flakes, hair, finger prints, sneeze particles, and residual water contaminants.

3) A special class of contaminants were created from meteoroid and debris (M/D) impacts. These contaminants were caused when an impact would occur on a bolt or part of a mount near an optic. The result of the impact was to spray molten metal across the nearby sample. Other effects of impacts were to cause localized damage or fracture of a sample as will be shown in the video.

4) Molecular contamination was observed throughout LDEF. In some areas it was quite thick. The Nomarski could detect the presence of this type of contamination, but other methods had to be used to determine its composition.

5) There were indications of cross contamination, not only from the shuttle and other external sources, but also from experiment to experiment. Because of the longer than expected exposure in space, some of the experiments disintegrated and eventually contaminated other experiments. The cross contamination was certainly aggravated during the LDEF recovery and shuttle landing. Aluminized mylar, Kapton (many sources), and radar camouflage materials (M0003) were some of the contaminants found on other experiment surfaces indicating cross-contamination.

OVERVIEW VIDEO

Due to the high volume of data, a short 10-minute video has been compiled to illustrate the different contamination processes observed on LDEF and discussed above. A short description of each video subject will follow below that will include the experiment number-tray location (for example A0023-C9), field-of-view size and video elapsed time in parenthesis. There are three sections of the video that are titled: 1) Fiber, Particulate, and Misc. Contamination; 2) Meteoroid and Debris Impacts; 3) Atomic Oxygen Erosion of Organic Composites.

FIBER, PARTICULATE, AND MISC. CONTAMINATION

- 1) Fiber ball, Exp. A0023-C9, FOV = 2-mm, (0-34 seconds).
- 2) Unidentified red contamination with halo (oblique lighting shows the color). This material was found on several experiments. Exp. A0201-C3, FOV = 2-mm and 1-mm, (34 sec. to 2-min.).
- 3) Evaporated liquid with some left over residual material. Could be salt mist or a sneeze particle. Both were found in other studies. Exp. A0201-C3, FOV = 1-mm, (2:02 to 2:23).
- 4) This frame shows the shadowing phenomenon on a Silver Teflon blanket. The familiar comet tails were seen all over LDEF. The frame stops at an imbedded fiber that was obviously present throughout the mission. Exp. A0178-A4, FOV = 2-mm and 1-mm, (2:24 to 2:47).

- 5) Fibers and a meteoroid hit, Exp. A0187-C2, FOV = 2-mm, (2:48 to 3:05).
- 6) This frame shows some of the aluminized mylar foil that was found everywhere including floating in SAEF II. Exp. A0147-B8, FOV = 2-mm and 0.5-mm, (3:07 to 3:27).
- 7) More evaporated liquid probably salt mist, Exp. A0147-B8, FOV = 2-mm and 0.5-mm, (3:28 to 3:53).
- 8) Imbedded fiber with some shadowing, Exp. M0004, FOV = 2-mm, (3:54 to 4:13).
- 9) Another fiber with very localized shadowing just under the fiber. Exp. M0004-F8, FOV = 0.5-mm, (4:14 to 4:37).
- 10) More of the red contamination like the material described in frame #2 yet found on a different experiment. Exp. M0004-F8, FOV = 2-mm and 0.5-mm (4:39 to 5:10).

METEOROID AND DEBRIS IMPACTS

- 11) Impact on a Silver Teflon blanket, the fissures radiating from the impact are quite distinct. Exp. A0178-A4, FOV = 0.5-mm, (5:22 to 6:23).
- 12) M/D impact with impact spray on to nearby sample. Next move up to nearby imbedded fiber. Exp. A0187-2-C2, FOV = 2-mm, (6:24 to 7:26).
- 13) Demonstrates meteoroid hit on a mesh. Exp. S0010-B9, FOV = 0.5-mm, (7:27 to 7:43).
- 14) Dramatic edge impact with molten metal spray. Exp. A0056-B8, FOV = 2-mm and 0.5-mm, (7:45 to 8:15).
- 15) Impact on a germanium sample, Exp. A0056-B8, FOV = 2-mm, (8:17 to 8:51).

ATOMIC OXYGEN EROSION OF ORGANIC COMPOSITES

- 16) Atomic oxygen erosion of a graphite epoxy composite. Loose glass fibers are shown everywhere. Exp. S0010-B9, FOV = 2-mm and 1-mm, (9:04 to 10:05).

CONCLUSIONS

This report has discussed the contamination study done with the Nomarski microscope during the deintegration of LDEF at KSC. As has been stated, this was a first step in a comprehensive contamination program to determine the history of contamination on

LDEF. For a complete report on the full results of this study compiled by Boeing Aerospace, the reader is referred to references 3-5. A video is included with this report as a sample of the 15 hours of video that was taken.

REFERENCES

- 1) The Long Duration Exposure Facility (LDEF) Mission 1 Experiments, NASA SP-473, 1984.
- 2) O'Neal, R. and Lightner, E., "Long Duration Exposure Facility - A General Overview", LDEF 69 Months in Space - First Post-Retrieval Symposium, June 1991.
- 3) Crutcher, E.R. and Wascher, W., "Particle Types and Sources Associated with LDEF", LDEF 69 Months in Space - First Post-Retrieval Symposium, June 1991.
- 4) Crutcher, E.R., et al., "Migration and Generation of Contaminants From Launch Through Recovery: LDEF Case History", LDEF 69 Months in Space - First Post-Retrieval Symposium, June 1991.
- 5) Crutcher, E.R., et al., "Quantification of Contaminants Associated With LDEF", LDEF 69 Months in Space - First Post-Retrieval Symposium, June 1991.

ACKNOWLEDGEMENTS

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APPENDIX A

Table 1.- LDEF experiment complement

| EXP. NO. | TITLE | TRAY NOS. |
|----------|---|-------------------------|
| A0015 | Free-Flyer Biostack Experiment Institute fur Flugmedizin, DFVLR | C2, G2 |
| A0019 | Influence of Extended Exposure in Space on Mechanical Properties of High-Toughness Graphite-Epoxy Composite Material University of Michigan | 012 |
| A0023 | Multiple Foil Micromabrasion Package University of Kent | C3, C9, 012, E6, H11 |
| A0034 | Atomic Oxygen Stimulated Outgassing Southern University/NASA-MSFC | C3, C9 |
| A0038 | Interstellar Gas Experiment NASA-JSC/University of Bern | E12, F6, H6, H9 |
| A0044 | Holographic Data Storage Crystals for LDEF Georgia Institute of Technology | E9 |
| A0054 | Space Plasma High Voltage Drainage TRW Space and Technology Group | 84, 010 |
| A0056 | Exposure to Space Radiation of High-Performance Infrared Multilayer Filters and Materials Technology Experiments University of Reading/British Aerospace | 88, G12 |
| A0076 | Cascade Variable Conductance Heat Pipe McDonnell Douglas Astronautics Company | F9 |
| A0114 | Interaction of Atomic Oxygen with Solid Surfaces at Orbital Altitudes University of Alabama in Huntsville/NASA-MSFC | C3, C9 |
| A0133 | Effect of Space Environment on Space Based Radar Phased Array Antenna Grumman Aerospace Corporation | H7 |
| A0134 | Space Exposure of Composite Materials for Large Space Structures NASA-LaRC | 89 |

APPENDIX A

Table 1.- (continued)

| EXP. NO. | TITLE | TRAY NOS. |
|----------|--|-----------|
| A0135 | Effect of Space Exposure on Pyroelectric Infrared Detectors NASA-LaRC | 65 |
| A0138-1 | Study of Meteoroid Impact Craters on Various Materials CERT/ONERA-DERTS | 83 |
| A0138-2 | Attempt at Dust Debris Collection with Stacked Detectors CERT/ONERA-DERTS | 83 |
| A0138-3 | Thin Metal Film and Multilayers Experiment CNRS/LPSP | 83 |
| A0138-4 | Vacuum Deposited Optical Coatings Experiment Optical Division, Matra S. A. | 83 |
| A0138-5 | Ruled and Holographic Gratings Experiment Inst. SA/JOB IN-YVON Division | 83 |
| A0138-6 | Thermal Control Coatings Experiment CERT/ONERA-DERTS, CNES/CST | 83 |
| A0138-7 | Optical Fibers and Components Experiment CERT/ONERA-DERTS | 83 |
| A0138-8 | Effect of Space Exposure of Some Epoxy Matrix Composites on Their Thermal Expansion and Mechanical Properties Space Division, Matra S. A. | 83 |
| A0138-9 | The Effect of the Space Environment on Composite Materials Aerospatiale | 83 |
| A0138-10 | Microwelding of Various Metallic Materials Under Ultravacuum Aerospatiale | 83 |
| A0139A | Growth of Crystals from Solutions in Low Gravity Rockwell International Science Center Technical University of Denmark | 66 |

APPENDIX A

Table I. (continued)

| EXP. NO. | TITLE | TRAY NOS. |
|----------|---|---|
| A0147 | Passive Exposure of Earth Radiation Budget Experiment Components The Eppley Laboratory, Inc. | B8, G12 |
| A0171 | Solar Array Materials Passive LDEF Experiment NASA-MSFC/NASA-LaRC/NASA-GSFC Jet Propulsion Laboratory | A8 |
| A0172 | Effects of Solar Radiation on Glasses NASA-MSFC/Vanderbilt University | D2, G12 |
| A0175 | Evaluation of Long-Duration Exposure to the Natural Space Environment on Granite-Polyimide and Graphite-Epoxy Mechanical Properties Rockwell International Corp. (Tulsa Facility) | A1, A7 |
| A0178 | A High Resolution Study of Ultra-Heavy Cosmic Ray Nuclei Dublin Inst. for Advanced Studies, ESA-ESTEC | A2, A4, A10, 95, B7, C5, C6, C8, C11, D1, D5, D7, D11, E2, E10, F4 |
| A0180 | The Effect of Space Environment Exposure on the Properties of Polymer Matrix Composite Materials University of Toronto | D12 |
| A0187-1 | Chemistry of Micrometeoroids NASA-JSC/Univ. of Washington, Rockwell Int. Science Center | A3 A11 |
| A0187-2 | Chemical and Isotopic Measurements of Micrometeoroids by Secondary Ion Mass Spectrometry McDonnell Center for the Space Sciences Max-Planck Institute for Nuclear Physics Munich Technical University Ernst-Mach Institute Dornier System Manufacturing Company | C2, E3, E8 |
| A0189 | Study of Factors Determining the Radiation Sensitivity of Quartz Crystal Oscillators Martin Marietta Laboratories | D2 |
| A0201 | Interplanetary Dust Experiment Institute for Space Science and Technology NASA-LaRC North Carolina State University | B12, C3, C9, D6, G10, H11 |

APPENDIX A

Table 1.- (continued)

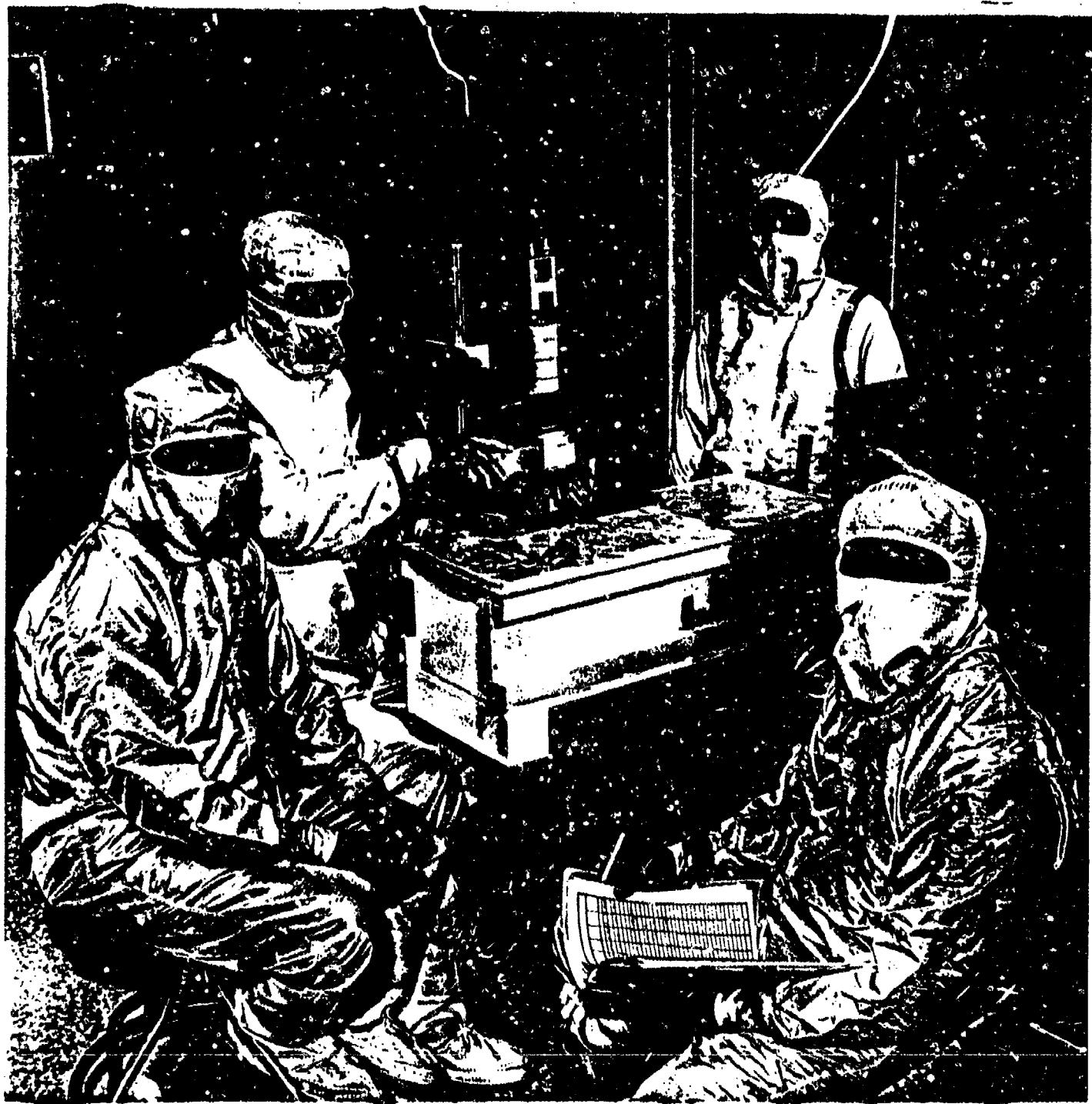
| EXP. NO. | TITLE | TRAY NOS. |
|----------|--|---|
| M0001 | Heavy Ions in Space Naval Research Laboratory | H3, H12 |
| M0002-1 | Trapped Proton Energy Spectrum Determination AF Geophysics Laboratory | D3, D9, G12 |
| M0002-2 | Measurement of Heavy Cosmic-Ray Nuclei on LDEF University of Kiel, Federal Republic of Germany | E6 |
| M0003 | Space Environment Effects on Spacecraft Materials The Aerospace Corporation | D3, D4, D8, D9 |
| M0004 | Space Environment Effects on Fiber Optics Systems AF Weapons Laboratory | F8 |
| M0006 | Space Environment Effects AF Technical Applications Center | C2 |
| P0003 | LDEF Thermal Measurements System NASA-LaRC | Center ring |
| P0004-1 | Seeds in Space Experiment George W. Park Seed Company, Inc. | F2 |
| P0004-2 | Space-Exposed Experiment Developed for Students (SEEDS) NASA Headquarters | F2 |
| P0005 | Space Aging of Solid Rocket Materials Morton-Thiokol, Inc. | Center ring |
| P0006 | Linear Energy Transfer Spectrum Measurement Experiment University of San Francisco/NASA-HSFC | F2 |
| S0001 | Space Debris Impact Experiment NASA-LaRC | A5, A6, A12, B1, B2, B6, B8, B11, C4, C7, D2, D6, E1, E4, E7, E11, F1, F3, F5, F7, F10, F11, G4, G8, H5 |

APPENDIX A

Table I.- (concluded)

| EXP. NO. | TITLE | TRAY NOS. |
|----------|---|-----------|
| S0010 | Exposure of Spacecraft Coatings NASA-LaRC | 99 |
| S0014 | Advanced Photovoltaic Experiment NASA-LaRC | E9 |
| S0050 | Investigation of the Effects of Long Duration Exposure of Active Optical System Components Engr. Exp. Station, Georgia Inst. of Technology | E5 |
| S0050-1 | Investigation of the Effects of Long Duration Exposure on Active Optical Materials and UV Detectors NASA-LaRC | E5 |
| S0069 | Thermal Control Surfaces Experiment NASA-MSFC | A9 |
| S0109 | Fiber Optic Data Transmission Experiment Jet Propulsion Laboratory | C12 |
| S1001 | Low Temperature Heat Pipe NASA-GSFC/NASA-ARC | F12, H1 |
| S1002 | Investigation of Critical Surface Degradation Effects on Coatings and Solar Cells Developed in Germany Messerschmitt-Bolkow-Blohm Space Division | E3 |
| S1003 | Ion Beam Textured and Coated Surfaces Experiment NASA-LaRC | E6 |
| S1005 | Transverse Flat Plate Heat Pipe Experiment NASA-MSFC/Grumman Aerospace Corporation | 810 |
| S1006 | Balloon Materials Degradation Texas A&M University | E6 |

APPENDIX B



APPENDIX C

| TRAY NUMBER | EXPERIMENTS |
|---|----------------------------|
| A01 | A0175 |
| A04 | GROUND STRAP AND A0178 |
| A07 | A0175 |
| B03 | A0138 |
| B08 | S0001, A0056, A0147 |
| B09 | A0134, S0010 |
| B11 | S0001 |
| C02 | A0187-2, A0015 |
| C03 | A0034, A0201 |
| C05 | A0178 |
| C08 | A0178 |
| C09 | A0034, A0023, A0201, A0114 |
| D02 | A0172 |
| D07 | A0178 |
| D11 | A0178 |
| D12 | A0180 |
| E05 | S0050-1 |
| E06 | M0002, S1003 |
| E08 | A0187-2 |
| F02 | Ag/FEP MATERIAL OVER SEEDS |
| F08 | M0004 |
| G02 | A0015 |
| G10 | A0201, A0056 |
| G12 | M0002 |
| H06 | A0038 |
| H07 | A0133-8 |
| MISC. GROUND CLIPS, KNURLED KNOBS, PAINT BUTTONS | |